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LATVIAN STUDENTS' UNDERSTANDING ABOUT THE ROLE OF WIDESPREAD NON-METALLIC COMPOUNDS IN ENVIRONMENTAL CHEMICAL PROCESSES

ROZUMIENIE ROLI NIEMETALI W PROCESACH CHEMICZNYCH ZACHODZĄCYCH W ŚRODOWISKU PRZEZ STUDENTÓW ŁOTEWSKICH

Abstract: The standard of professional high school education in Latvia envisages including environmental education in the contents of professional schools as a separate subject, however, we see in practice that there are not teaching materials in chemistry education and environmental education provided for professional schools. The problem is even more acute due to the fact that the time provided for teaching chemistry in professional schools is approximately 3 times shorter than that in secondary schools. The research shows us that approximately 40% of professional high school students have knowledge about the character of chemical processes taking place in the environment. One of the main reasons for this insufficiency and the lack of understanding is the absence of didactical teaching materials.

Keywords: environmental education, chemistry education, professional education, integration of education

The environment where humans live nowadays consists of several environmental compartments - atmosphere (the air we breathe), hydrosphere (the water we use), lithosphere (soil). The activities made by humans influence the chemical behaviour of those environmental systems; therefore, humans have to be aware of the consequences interfering in natural processes. The protection of the environment and the effectiveness of environmental management depend on both the educated specialists and the education of society on environmental subjects.

Environmental education is the teaching/learning methods based on the aspirations of society to form healthy environment and live in an environmentally friendly society according to nature; in the same time solving actual problems of developing society. In order to develop the basics of environmental education system we have to consider all educational levels (primary school, secondary, high, professional schools and life-long education).

The task of our research was to ascertain the understanding of professional school students in Latvia about ecological problems connected with chemical processes and chemical substances that are formed as a result of activities of humans in the environment and the influence on nature and human beings.

In this article we give the results of the first phase of our research taking place in Riga Technical University's (RTU) Liepaja branch.

Methods of approach in acquiring environmental education

Environmental studies as the component of interdisciplinary teaching/learning process

Environmental education is a branch that tends to avoid specialized approach. It forms a relationship "science - technology - environment - society" [1]. According to this view

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students acquire environmental studies in integrated way - as a part of chemistry, physics and other natural sciences in many countries all over the world:

- In Germany's secondary schools (Hauptschule, Realschule, Gymnasium) environmental studies are components of *biology, geography, social studies*. In addition *Chemistry, physics, religion* give considerable investment in environmental education [www-1].
- In Poland basic teaching plan foresees to include interdisciplinary course of environmental studies in all subjects [2].
- National education standard of Estonia foresees the integration of environmental education in the context of all subjects in comprehensive and vocational (professional) schools [www-2].
- In Russia the Federal rule known as "The Protection of the Environment" was adopted in 2002; it anticipates forming a complex ecological education. Ecological education is included both in comprehensive and professional schools as a part of *biology, law, society studies*. However, they study the basics of ecological education included in subjects "ecology", "the basics of ecology", "nature protection" in some public and private schools [www-3].

The positive aspect of this approach is that students acquire knowledge that reveals the processes taking place in the environment from the point of view of various science branches.

The lack in this approach is the fact that students study only the issues connected with processes in this subject (in physics - physical pollution, in chemistry - chemical pollution, in biology - biological pollution, in geography - the problems of the distinction of nature resources). Therefore it is possible that a student is not able to see all problems connected with the environment as a whole. The issues connected with the environment could repeat. For example, the effects of Chernobyl accident are discussed in all above-mentioned subjects (chemistry - nuclear reactions, physics - radioactivity, biology - mutation, geography - pollution transfer). Thus, being repeated, a student can lose interest and understanding about the importance of knowledge.

Environmental studies as a part of independent education structure

The second approach - the acquiring of environmental education as a separate subject, allows us to gain knowledge about a wider scope of ecological issues but not always it can connect the ecological problems with the branch that has caused it. This approach is used in studies in colleges [www-4; www-5].

In the teaching/learning structure in Latvia we use both approaches in comprehensive schools:

- In comprehensive education students acquire issues interdisciplinary. They are integrated in the contents of other science subjects - in chemistry, physics, biology, geography [www-6].
- In professional schools (vocational, technical, professional high schools) students study environmental science.

There are only few opportunities to accent the bond *chemistry* ↔ *environmental science* due to the lack of time, teaching materials and fewer teaching lessons in timetable in professional schools for acquiring chemistry and environmental science. The positive

aspect is that students acquire environmental science systematically using a definite teaching plan.

Materials and methods

The first phase of our survey - students' understanding about environmental questions in connection with chemical processes took place in RTU Liepaja branch. It is a unique multistage teaching establishment in Latvia where students can start their studies in a professional school after having got basic education. Such students can continue their chosen studies in college programs, professional bachelor or academical bachelor programs. After acquiring these programs students have possibility to study in Master of Science programs.

A survey was conducted using closed type questions. This was necessary in order to collect information about students' understanding connected with chemical processes in the environment. One of the reasons for that, there are not teaching materials in chemistry and environmental sciences for professional school students. The survey included 190 RTU Liepaja branch students. We compared three independent groups (No. 1, No. 2, No. 3) knowledge in chemical processes in the environment.

- RTU Liepaja branch students who had received their secondary education in comprehensive high schools, where environmental issues are integrated in the chemistry course (No. 1).
- RTU Liepaja branch students who have finished RTU Liepaja branch professional school (No. 2) and have studied *Chemistry* and *Environmental Science*.
- Current RTU Liepaja branch students who studied subjects *Chemistry* and *Environmental Science* in the 2008/09 academic year (No. 3).

The survey questions were connected with the chemical nature of natural and anthropogenic processes taking place in the environment. The competence of RTU Liepaja branch students in environmental questions in connection with chemical processes was evaluated by analyzing answers to 15 questions presented in the survey. Students had to choose one from four given answers which was the more precise from their point of view. One of the answers was incorrect, two were only partly precise, but the 4^{th} was completely correct. Coding answer variations and giving them points from 1-4, we received the answer Moda, which variated from 2.00 to 3.00 in most cases. It shows that students have mediocre level of understanding evaluating environmental problems. It allowed specifying more characteristic mistakes in students' answers.

We chose the group of the issues because there is a very strong anthropogenic influence on the planet and all nature resource users and producers of material values have to know the causes of this influence and the consequences of pollution.

The validity of the survey, credibility on the whole, its suitability for cultural environment was characterized by Kronbach-Alpha coefficient - "α", and a suitability of every question by coefficient "s". Since "α" was 0.43 in our case, we were able to consider that complex of given questions was suitable for students.

We worked on data with computer program Excel and SPSS used in social sciences. Statistics allowed us to conclude about both positive aspects and lack in students' knowledge and plan further strategy.

Results and discussion

We give the answers of respondents to the problems connected with various pollution forms of the environment with IVA and VA group non-metallic elements (carbon, silicon, nitrogen and phosphorus) compounds.

Nowadays a problematic issue is atmospheric pollution with sulphur and nitrogen oxides which cause acid rain. The main resources of anthropogenic origin of these compounds are fuel burning. 70% from all SO_2 waste comes from coal burning [3]. The pollution is not considerable both on the whole and considering one inhabitant in Latvia. However, if we speak about NO_2 pollution in USA and Western Europe 50% from NO_2 emission comes from cars while it is 70% in Latvia [4]. The potential source of acid rain in Liepaja is the plant "Liepajas Metalurgs". Therefore the first question to respondents was about their competence in non-metallic element oxides causing acid rain (1. question, s = 0.712). This question is significant both for all specialists nowadays who are connected with branches where there are emission of nitrogen and sulphur compounds and also every driver. Mean index in correct answers was 39.5%. The best results showed the respondent group (No. 2) - RTU Liepaja branch students who have finished RTU Liepaja branch professional high school and continue studies in university - 42.9%. Weaker results were showed by group No. 1 who studies in university after finishing a secondary school - 37.8% and group No. 3 who had studied both chemistry and environmental sciences - 39.8%. Most part of the respondents who gave incorrect answer thought that acid rain is caused by sulphur and carbon oxides - it gives proof of insufficient knowledge in the qualities of inorganic acids.

Respondents gave answers to the question about the influence of acid rain on objects made from marble and limestone (2. question, s = 0.636). It is known that acid rain damages architectural and historical monuments. The rain with sulphur causes corrosion in these objects. The damage of the monuments causes the loss of aesthetical values as well as a great material loss. Average in correct answers was 19.5%. The best knowledge in this question showed RTU Liepaja branch professional high school students (26.1% correct answers) who acquired subjects *Chemistry* and *Environmental sciences* in the year 2008/09. The weakest results had the group consisting of RTU Liepaja branch professional high school graduates - 5% correct answers. It can be explained with their bad knowledge of historical names of chemical compounds.

The 3rd question was formulated according to acid rain, s = 0.722 (rain water pH = 2.0÷4.5). The question was connected with the water clearness both in swimming places and the quality of drinking water because drinking water is taken from open reservoirs in many places in Latvia. As we see from data in Table 1 there are more correct answers comparing with other questions (average 60%). It can be explained with the fact both professional high school and university students have done laboratory works on pH in various solutions.

Nowadays an actual problem is eutrophication (over growing of reservoirs) caused by anthropogenic water pollution. This process is due to phosphoric compounds [5]. The 4th question (s = 0.694) was about chemical elements causing the growing up of reservoirs most of all. Correct answers were given by 38.2% of respondents. RTU Liepaja branch students studied in professional high school gave the most successful answers. Most of the incorrect authors thought that carbon compounds are the reason for eutrophication. Thus we

can conclude that students' knowledge about chemical elements being in mineral fertilizers is poor. We can declare that the integration of chemistry and environmental sciences problems concerning IVA and VA group non-metallic elements role in nature processes in teaching/learning processes is insufficient.

Comparing competence coefficient k (k = correct answers/the whole number of answers), we received following results: 1. selection - k = 0.38, 2. selection - k = 0.38 and 3. selection - k = 0.39.

Thus we conclude that the level of students' knowledge about chemical processes in the environment does not depend on the educational establishment where they received secondary education.

Table 1

RTU Liepaja branch students survey results (right answers from the selected number of respondents)

Selection	1. question		2. question		3. question		4. question		k
	number	[%]	number	[%]	number	[%]	number	[%]	
No. 1 = 82	31	37.8	13	15.9	51	62.2	30	36.6	0.38
No. 2 = 20	9	42.9	1	5.0	12	60.0	9	45.0	0.38
No. 3 = 88	35	40.2	23	26.1	51	57.9	29	33.0	0.39
Total 190	75	39.5	37	19.5	114	60	68	38.2	

We plan to continue our research including students, teachers, lecturers from professional schools and high schools in Latvia.

Conclusions

In order to promote professional school students' understanding about the world as a unified and indivisible whole we need to teach subjects *Chemistry* and *Environmental science* with advised enactment.

1. The results of the survey showed that only approximately one third of RTU Liepaja branch students completely understand the chemical basics of processes taking place in the environment and are able to connect the knowledge gained in chemistry and environmental sciences lessons.
2. The analysis of the survey results showed that the quality of students' knowledge does not depend on the methods used in teaching/learning chemical processes in the environment; it is determined by students' ability to notice relationship, to reason and draw conclusions.
3. It is necessary to create new teaching materials that will effectively bond chemistry with environmental studies to ease work on acquiring knowledge about chemical processes in the environment.

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ROZUMIENIE ROLI NIEMETALI W PROCESACH CHEMICZNYCH ZACHODZĄCYCH W ŚRODOWISKU PRZEZ STUDENTÓW ŁOTEWSKICH

Abstrakt: Standardy wyższego kształcenia zawodowego w szkołach na Łotwie przewidują, że w programie nauczania tych szkół edukacja środowiskowa stanowi odrębny przedmiot nauczania. Jednak w praktyce brak jest materiałów dydaktycznych do prowadzenia w tych szkołach nauki chemii i edukacji środowiskowej. Problem ten jest jeszcze bardziej znaczący ze względu na czas przewidziany na nauczanie chemii w szkołach zawodowych, jest on około 3 razy krótszy niż w szkołach średnich. Wyniki badań pokazują, że tylko około 40% uczniów szkół zawodowych posiada wiedzę na temat charakteru procesów chemicznych zachodzących w środowisku. Jednym z głównych powodów tak niskiego poziomu nauczania i braku zrozumienia jest brak odpowiednich materiałów dydaktycznych.

Słowa kluczowe: edukacja środowiskowa, edukacja chemiczna, szkolnictwo zawodowe, nauczanie zintegrowane